ERGONOMIC INTERVENTIONS AT UNIMIN

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Abstract

In 2004, management at Unimin's Gleason, TN operation began implementing ergonomic interventions specifically targeted to reduce risk of musculoskeletal injuries (MSIs). Together with corporate and site management, Unimin identified work site hazards and began to modify work practices/equipment. Some interventions were relatively simple and were implemented immediately. Others, like improvements to a mobile shredder, were more complex but were eventually resolved through a participatory approach with employees, management, manufacturers and NIOSH. This paper discusses ergonomic interventions that were successfully implemented using a bottom-up approach to reducing the risk of injury.

Introduction

Unimin is an industrial minerals mining company with more than 100 operations worldwide. Unimin produces ball clay, silica, kaolin clay, dolomite, nepheline syenite, and olivine. The Gleason, TN site is a ball clay surface mining facility and a processing facility. Ball clay is a product used mostly for ceramic fixtures and as a bonding agent in ceramic ware. When compared to many other Unimin mines, the Gleason site was experiencing a higher percentage of MSIs (categorized as sprains and strain injuries in an injury database generated by Unimin) for the period of 2000 through 2006. During that period MSIs accounted for 44% of all reported incidents at Gleason compared to 26% for all of Unimin. The management team at Gleason continuously searched for means to improve the working environment. In order to identify improvements that would have the most dramatic impact on MSIs, the management team approached miners individually and discussed their concerns and thoughts on work practices that required significant physical exertion or were repetitive.

Although no formal ergonomics process was established, training was given to the site safety and health supervisor by NIOSH researchers. This resulted in ergonomic principles being incorporated into the established safety processes at Gleason. Under the guidance of NIOSH researchers several significant interventions were successfully implemented, which are described in the next section. The goal of this collaboration was to develop interventions to reduce the likelihood of injuries resulting from awkward postures or excessive forces.

Interventions

Shredder Power Cable Connector

Due to the nature of ball clay, some unusual equipment is required to process it, such as a clay shredder, which shreds raw clay and disperses it onto a stock pile. The shredders used at Gleason are mobile and on average are moved twice daily using a front end loader. Each time the shredder is moved it must be connected /disconnected to a power source. Because the connector weighs 20 pounds and is difficult to handle, forceful exertions and awkward postures occur when performing this task.

During discussions with the employees, Gleason mine management became aware of difficulties in connecting and disconnecting the shredder power cable (Figure 1). Issues of concern included the following:

1) The aluminum sleeve became bent, which made it difficult to connect and disconnect from the receptacle.

2) Hardened and built up clay on the connectors made it difficult to insert into the receptacle.

3) Dust on the aluminum sleeve made it more difficult to connect.

4) Awkward postures (rounded back, arm position with respect to the body, and standing on uneven ground) occurred when connecting and disconnecting the cable to the power source.

Based on the issues above, a possible solution of using an off-the-shelf cable connector was considered. Features of this connector were its light weight (5.2 lbs) and ability to form an easier connection – it had concealed components that remained hidden until the connection was made, which kept the male end free of dirt and debris. The connector also eliminated arc flash exposure and had an accessory tool especially designed to aid in connecting/disconnecting. A significant capital investment was needed to purchase the male/female connectors and the accessory tool, and to install all related equipment.

Figure 1. Mine worker demonstrates power connection.

Mine management obtained a sample of the parts necessary for installing the new connector from an equipment vendor. They, in turn, asked nearby mines regarding any experience their operations had in using this type of connectors. The feedback received from the other operations was negative – the external recessed areas of the connectors became clogged with clay particles, and if excessive force was used when making a connection, parts of the connector easily bent. Based on this feedback and a potential capital investment of more than $11,000, the mine management rejected the new connector option.

Figure 2. The rubber "boot" to protect the male cable connector from dirt, dust, and damage.

Subsequently, mine management came up with other options in conjunction with maintenance personnel and shredder operators. This resulted in the following actions:

1) A rubber boot (Figure 2) for the aluminum sleeve was installed on the male end to prevent the sleeve from bending and to keep it clean. The rubber boot was made from a protective cover for a dust collector cartridge that the mine normally stocks.

2) An electric grinder was used to file burrs on the inside of the connectors to make insertion of the plug easier.

3) A spray lubricant, commonly known as "Super Slick," was applied to the contacts and sleeve of the connector to reduce friction when inserting the connector into the receptacle.

The Gleason mine safety and health supervisor estimated the cost of this intervention as $500 in materials and man-hours. He indicated that the "employees liked the results" and described the intervention process and outcome as "very good".

Cable Handling

Another issue associated with the shredder was how to minimize injury risk when handling the power cable. The specific components of this task included unraveling the cable from its storage device, holding the connector and dragging the cable to and from the power source receptacle, and then placing the cable back on the machine in preparation for another move.

Initially, a mechanized cable reel was considered as an option to reduce the physical cable handling. A cable reel manufacturer was enlisted to assist with this option. Given the available space to mount the real within the frame of the shredder, an initial design was developed and supplied to mine management. One major limitation of the power reel was that although it provided cable retrieval capability, employees would still have to pull the cable off the reel to connect to the power source. Also, an estimated cost of the power reel solution for four shredder machines exceeded $38,000. After considering the limitations and costs of the power cable reel, mine management rejected this option.

Afterwards, the mine management team considered a low-cost and simple solution to the cable handling issue offered by an off-shift shredder operator who was listening to the conversation between the NIOSH researchers and a fellow operator. This involved a procedural change to cable handling that constituted a method of looping the cable in 10 foot lengths (as seen in Figure 3b), so that only a 10 foot length of cable is handled at a time instead of a haphazardly over-lapping bundle. NIOSH researchers determined that overlapping the cable (as seen in Figure 3a) while unwinding it, increased the force required by approximately one third (mean forces for small drag at 18.5 pound-force with no cable overlap versus 25.5 pound-force needed when overlapped cable).

This intervention, including training for all workers, was implemented by Gleason Mine management quickly and at no cost. The mine safety and health supervisor stated that this intervention "was a good partial solution" and was accepted fairly well, although a few operators still try to "manhandle" the cable. This solution, even though not optimal as yet, helped to reduce the amount of load handled by 28% and raised the awareness of the employees while a more cost effective solution can be further explored.

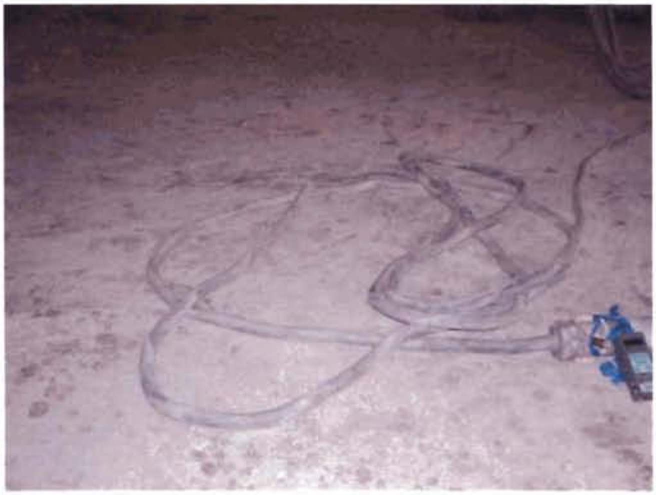

Figure 3a. Shredder cable haphazardly over-lapped.

Figure 3b. Shredder cable evenly looped.

Cleaning and Maintaining Tub

A third intervention concerning the shredder was for the "tub" which requires regular cleaning and maintenance. As before, issues were identified as a result of feedback from the shredder operators. Injury risk factors for this task included awkward postures while climbing into or leaning over the side of the tub to remove large pieces of rock. Before the intervention, employees would climb over the side of the tub to clean it out, to change knives, and to remove large pieces of rock and clay. This placed employees in postures that could lead to back and shoulder strains. The tub has a diameter of 62 inches and is 55 inches high (measured from the base inside the tub). Considering that half the male population and 95 percent of the female population have a shoulder height of less than 56 inches, the tub height posed a significant barrier. Both men and women would have to lean over the rim of the tub to retrieve rocks (typically weighing 50 to 60 pounds) and then throw them over the tub at shoulder height. Mine management was concerned about workers' safety, and the potential musculoskeletal injury risks when climbing in and out of the tub, leaning over the tub wall, and lifting rocks out of the tub.

A team consisting of mine management, maintenance personnel, and shredder operators conducted intensive brainstorming sessions to reach a low-cost effective solution. It resulted in cutting the tub to create a hinged door (Figures 4a and 4b). This intervention demonstrated the following benefits:

1) Reduced the risk factors associated with leaning over the side and climbing over the side of the tub. The worker was now able to walk into the tub to perform cleaning or maintenance duties.

2) Reduced the injury risk associated with lifting heavy rocks to shoulder height and above to throw them over the top of the tub side. Instead workers are able to use the door of the tub to easily slide out rocks and debris.

3) Allowed operators to safely carry maintenance tools into and out of the tub.

Figure 4a. Shredder tub with door installed.

Figure 4b. Worker easily removing large rocks when using door.

The Gleason mine safety and health supervisor estimated $1200 as the total cost of this intervention for all three shredders. He stated: "This intervention has been very well accepted. The process of brainstorming by the maintenance department and shredder operators...[with] the solutions reached by the parties involved was good. This was a remarkably simple, but very worthwhile intervention."

Handling Sodium Silicate

Another task which was improved as a result of the NIOSH-Unimin collaboration was the handling of a clay additive, sodium silicate. The sodium silicate is added in 50 pound increments to the ball clay slurry up to three times a day. Originally the additive was dispensed into a bucket and then carried along a catwalk for about 50 feet (Figure 5a). This catwalk was very narrow and forced workers to carry the bucket one handed in front of or behind their body or to walk sideways.

NIOSH researchers recommended extending the piping for the additive over to its destination to eliminate carrying the load. As shown in Figure 5b, it would still be necessary to pour the additive into the slurry by bucket, but workers would no longer carry it 50 feet. The cost of implementing the intervention was approximately $300. The installation was straightforward since the additive was already piped. They simply added a pump and lengthened the pipe. The employees liked the idea and quickly put it in place.

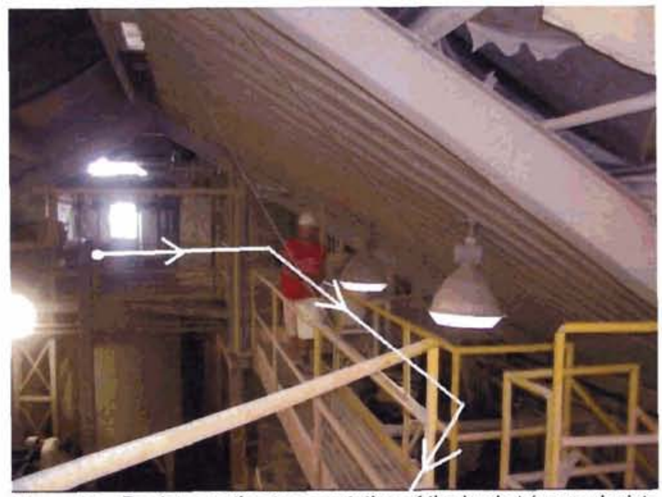

Figure 5a. Pre intervention transportation of the bucket (arrow depicts walking path).

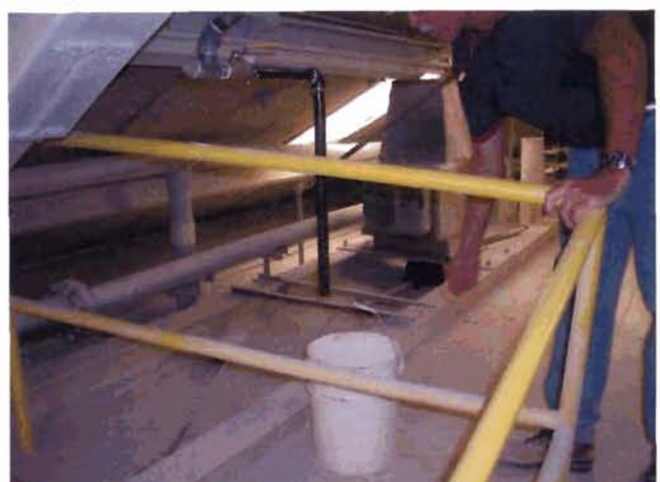

Figure 5b. Post intervention filling of the bucket (occurs at end of path way shown in Figure 5a).

The implementation of this intervention eliminated carrying the heavy load using awkward postures. The result is a reduction of the risk of sprain and strain injuries to the back and shoulders. This intervention could be enhanced even further by adding a hose with a metered valve to deliver the additive directly without any manual handling.

Age Awareness Training

The Age Awareness Training (AAT) was developed by NIOSH in response to the concern that an increasing number of older workers are remaining on the job. The training discusses normal age-related changes that have the potential to affect worker health and safety. Also addressed by the AAT is how these normal changes can be mediated through modifications to the workplace or improvements to personal health behaviors. The AAT includes seven training modules covering topics such as hearing, vision, and the musculoskeletal system.

During the collaboration it was determined that at the Gleason facility the median age was 45.5 (range 22-68) years and median length of mining experience was 19.5 (range 0-40) years. This diversity of the workforce lead to a decision to use Gleason as a field test location for the AAT during the summer and fall of 2006. The first "kick off" module (Introduction) was given at the start of a monthly safety meeting to about 60 employees and was followed with bi-weekly safety talks on each of the modules. Educating workers on issues related to the physical and cognitive aging process can be an effective way to reduce the possibility of injuries.

The Gleason Mine safety and health supervisor commented: "Overall the vision module (the first to be given in the bi-weekly format) was received rather well, and has provoked some good discussion and a few projects". For example, one intervention resulting from the vision module was applying anti-glare film on the windows of the mobile equipment at the mine pit. The effect of glare on an aging population was identified by the module as: "After age 40, changes in the lens and the vitreous gel [of the eye] cause the resistance to glare to decline by 50 percent every 12 years." Given that older workers may have problems adapting to situations with glare, adding anti-glare film reduced the risk of injury to the workers by allowing them to be able to distinguish any possible hazards.

Impact of the Interventions

Initially ergonomics and the application of its principles at Gleason were not readily accepted by the workforce. However, employee buy-in was generated through training and employee involvement in developing the interventions. The workers became more proactive about problem solving and developed and implemented many of the interventions discussed above with little guidance after the initial discussion of ergonomics principles. For the nine month period from January 1, 2006 to September 30, 2006 there has been only a single MSI reported as compared to the yearly average of approximately 4 MSIs (for the period of 2000-2005). This decrease in MSIs cannot directly be attributed to the interventions, but it may be due to increased awareness of the employees about risk factors. There has also been a noted reduction in the average modified duty days per MSI of approximately 23%. This reduction in modified duty days has resulted in an estimated savings to Gleason of approximately $14,000 in 2006. As the Age Awareness Training proceeds and the application of ergonomic principles becomes part of the mine's culture, additional interventions are expected to be implemented at Gleason over the next few years.

Conclusions

Several ergonomic interventions implemented at Unimin's Gleason mine reduced or eliminated a number of risk factors that could lead to injuries. By integrating ergonomics principles into existing safety processes, cost effective interventions were quickly and easily developed by the workers themselves. The success of the interventions stemmed from its participatory approach to problem solving; empowering all personnel with a voice in health and safety issues.

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Disclaimer

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